Reactive Rendezvous and Docking Sequencer, Phase I

Completed Technology Project (2010 - 2010)

Project Introduction

Mars Sample Return poses some of the most challenging operational activities of any NASA deep space mission. Rendezvous of a vehicle with a sample canister in order to return the canister to Earth requires a variety of complex mathematical processing on a changing data set, coupled with the need to safely and effectively handle a large range of off-nominal conditions and spacecraft faults. Light speed delay isolates the spacecraft from real-time operator intervention, while inertial and situational uncertainties demand reactivity not required of typical spacecraft sequencing systems. These mission features call for a new class of sequence capability: Reactive Rendezvous and Docking Sequencer (RRDS). RRDS melds the rule-based reactivity needed for rendezvous and docking with sequence characteristics common to more traditional missions. Rules watch for conditions in order to react to the current situation, allowing a wide range of complex activities and safety-related responses to be concisely represented without complex procedural programming. Built atop JPL's VML 2.1, RRDS uses state machines to react to a variety potential conditions simultaneously. Conditions include out-of-envelope inertial behavior, hardware malfunctions, flight software errors, and ground wave-off, among others. Responsibility for commanding elements aboard the spacecraft is divided among state machines called managers, coordinated together by a flight director which the ground commands. Underlying flight software for navigation, thruster allocation, inertial checking, attitude estimation and control, contact detection, docking mechanisms, and the like receive direction from the managers. This mediated control causes the system to reactively operate in modes with proper ordering of activities. Reactive operations are represented explicitly by states and transitions defining the managers, and do not require use of explicitly timed activities.

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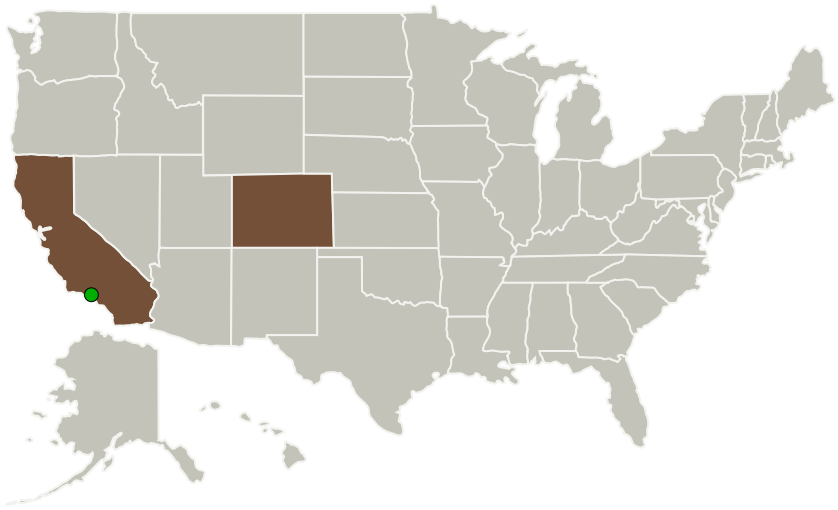
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Blue Sun Enterprise, Inc.	Lead Organization	Industry	Boulder, Colorado
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Colorado

Project Transitions

January 2010: Project Start

July 2010: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140049)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Blue Sun Enterprise, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Christopher Grasso

Co-Investigator:

Christopher Grasso

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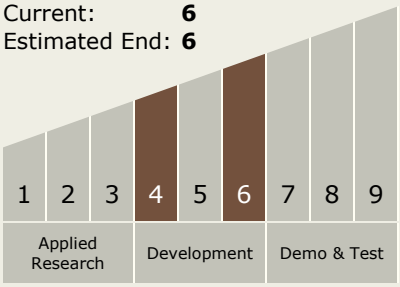
Technology Maturity (TRL)

Start: **4**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.5 Autonomous Rendezvous and Docking
    - TX04.5.2 Rendezvous & Docking Algorithms

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System